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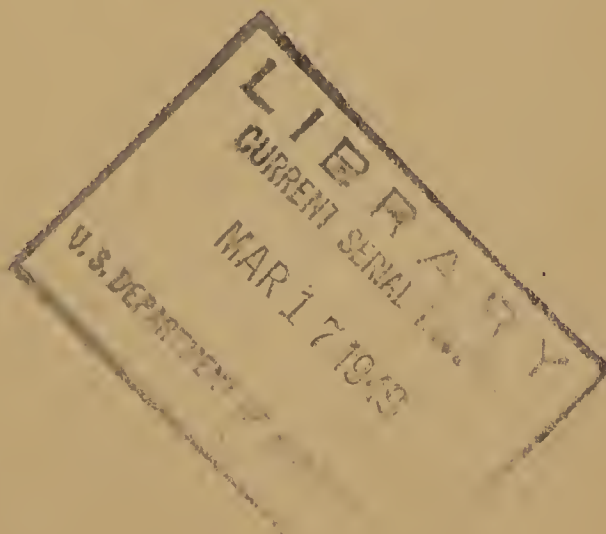
Conference Report  
on  
Cotton Insect Control  
Stoneville, Mississippi  
November 17-19, 1947

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This is a summary report of the conference held at Stoneville, Mississippi, November 17-19, 1947, by Federal and State workers concerned with cotton insect control. It brings together the results of research, especially with new insecticides, for the control of cotton insects.

This is designed to serve as a basis for recommendations on cotton insect control to be prepared by State agencies and the U. S. Department of Agriculture.

This report is being distributed to research workers, extension entomologists and to industry for their information. It is not for general distribution.



DEC 16 1947



Research and extension entomologists from ten cotton-growing States and the United States Department of Agriculture participated in a conference at the Delta Branch Experiment Station, Stoneville, Mississippi, November 17-19, 1947, to review and summarize their experiments and experiences in cotton insect control and to formulate a guiding statement for control recommendations in 1948. After a review of all available information, the statement that follows was unanimously approved.

Cultural methods of controlling cotton pests are not considered in this statement. However, their importance cannot be too strongly emphasized. It should be recognized that control by the use of insecticides is really supplemental to the adoption of good farm practices. These include such factors as early fall clean-up, seed treatment, early planting, fertilization, use of proper cotton varieties, proper land use, and cultivation. These measures are influenced by climate, soil conditions, fertility, topography, and geographical location. It is suggested that each State prepare its own recommendations for cotton insect control.

This statement contains recommendations for the use of certain insecticides for the control of cotton insects. It also presents information believed to be of value to industry in planning production programs and to cotton growers who may be contemplating the use of some of the insecticides that are still in an experimental stage. It contains some suggestions as to research needs in developing a more effective cotton insect control program. Control recommendations are presented in a general manner and are not specifically fitted to local needs. It is expected that each State will adapt to its own conditions the information given in this summary.

In quoting this statement, material should not be removed from the context. If the report is not reprinted in its entirety, no less than a complete section relating to one material or insect should be copied, and no portion of it should be used for advertising purposes.

#### Benzene Hexachloride

Results obtained throughout the Cotton Belt indicated that benzene hexachloride may be useful for control of the following insects: boll weevil, cotton aphid, cotton fleahopper, tarnished plant bug, rapid plant bug, cotton leafworm, thrips, southern green stink bug, garden webworm, and fall armyworm. Benzene hexachloride failed to control the bollworm and the red spider; and in many experiments it produced conditions which resulted in a great increase in their numbers. Benzene hexachloride killed many beneficial insects.

It has been found that accumulations in the soil of benzene hexachloride result in an objectionable taste being imparted to some root crops, particularly potatoes and there is a possibility that this may happen in such crops as peanuts when soil accumulations occur. Consequently, the use of benzene hexachloride on cotton is not recommended when root crops or peanuts are to be grown on the same soil during the next year and possibly during the second year after application until more is known about the hazard involved.



Results of experiments showed that a dosage of approximately one-third pound of gamma isomer (example: 10 pounds of benzene hexachloride dust containing 3% of the gamma isomer) per acre gave satisfactory control of the insects named in the preceding paragraph, and that one-half pound of gamma isomer gave a quick "knock out" of a heavy aphid population.

Tests thus far indicate that intervals between applications for boll weevil control should be not more than 4 to 5 days. Additional information is needed.

The following diluents have been used with satisfactory results: sulfur, pyrophyllite, and non-alkaline clays and talcs. When 40% sulfur was used as a diluent with benzene hexachloride, serious red spider infestations did not develop so long as the applications were continued.

Wind and convection currents greatly reduce the effectiveness of benzene hexachloride for aphid control.

As a cotton insecticide, definite advantages have resulted through mixture with other toxicants. A mixture containing 5% DDT, 3% gamma benzene hexachloride plus 40% sulfur has been especially effective.

The keeping qualities of benzene hexachloride dusts in storage are not fully known and need further investigation.

Cotton foliage burn has been variable. Heavy dosages of benzene hexachloride have burned young tender leaves under certain conditions, but this was usually of no economic importance.

The possibility of cottonseed having the taste and odor of the material following applications to the plants is now under investigation.

One season's data, largely from Florence and Blackville, South Carolina, indicate that quantities of benzene hexachloride equal to the amount (200 pounds) required for insect control over a 5-year period, when applied to the soil at the time of seeding, caused no apparent injury to any of 18 different crops. Higher rates caused injury to many of these crops, especially on very light soils, but even at the rate of 4000 pounds per acre of 3% gamma isomer, some plants survived, and these appeared to mature in a normal manner.

Benzene hexachloride has an objectionable odor and is irritating to the eyes and nasal passages, but further injurious effects have not been experienced from repeated exposure of several hours at a time over a period of several weeks. Little is known of possible cumulative effects over a longer period. Its toxicity to birds, mammals, and fish is little known.

Further research on benzene hexachloride is needed, especially on dosages, interval between applications, time of application, combinations with other insecticides, mode of action on insects, relation between its use and bollworm and red spider build-up, effect on beneficial insects, and toxicity to higher animals.



### Calcium Arsenate

Calcium arsenate is an economical and effective insecticide for boll weevil and cotton leafworm control. It also gives fairly good bollworm control when heavy poundages are used and infestations are not too heavy. Calcium arsenate will not control the pink bollworm, cotton fleahopper, cotton aphid, common red spider, tarnished plant bug, and rapid plant bug.

Calcium arsenate gives best control undiluted, i.e., without an inert diluent. It is used in dust mixtures with sulfur, rotenone, and nicotine. Mixtures of it with some of the new insecticides such as benzene hexachloride and (3422) diethyl-p-nitrophenyl thiophosphate have also been used. Regular calcium arsenate does not appear to be compatible with benzene hexachloride.

For boll weevil and cotton leafworm control, use at 7 to 10 pounds per acre. For bollworm control, use 12 to 16 pounds per acre. For cotton fleahopper, tarnished plant bug, and rapid plant bug, use 15 pounds per acre of a mixture composed of two-thirds sulfur and one-third calcium arsenate.

Calcium arsenate in certain light soils is injurious to some crops, especially legumes and oats. Drifting of the dust may injure soybeans and peach trees. It is poisonous and should be handled carefully. Livestock should be kept out of dusted fields. Care should be exercised when dusting near pastures, especially when airplanes are used. It is best to muzzle horses or mules used in cultivating poisoned fields. Calcium arsenate has excellent dusting qualities. It is usually available in sufficient quantities to meet normal demands for cotton insect control.

Calcium arsenate is recommended as a standard of comparison with organic insecticides against cotton insects for which it is effective.

### Chlordane

Results of some field tests indicated that a 10 percent chlordane dust gave boll weevil control equal to that of calcium arsenate, prevented an aphid build-up, and killed weevils developing in squares. Concentrations of less than 10% generally were not satisfactory. Red spider and bollworm infestations increased as a result of applications at this concentration.

Results of one test indicated that a 20 percent chlordane dust may be effective against the bollworm. In other experiments high infestations developed after applications of this mixture were discontinued. When at least 40 percent sulfur was used in the mixture, no red spider damage occurred.

Concentrations of 10 percent or less failed to give a "knock-out" control of aphids.



Chlordane seems to be compatible with the non-alkaline insecticides. There was no evidence of synergism when this material was mixed with DDT.

The toxicity of chlordane to man, animals, soil, etc., is little known, and additional research on this phase is needed.

This material has shown promise as a cotton insecticide, but additional research is needed to determine its effectiveness alone and in combination with other materials to control cotton insects before it can be generally recommended.

#### Commercial Mixture of 3% Chlordane and 3% DDT

Experimental work in several States showed that a commercial mixture of 3% chlordane and 3% DDT was inferior to calcium arsenate for control of boll weevils when applied at 4- or 5-day intervals. It exhibited no residual action beyond 4 or 5 days.

Cotton aphid and red spider infestations developed in some cases where the mixture was tested.

#### Chlorinated Camphene

Experiments have shown that chlorinated camphene will control the following cotton insects: boll weevil, bollworm, cotton fleahopper, thrips, cotton leafworm, southern green stink bug, rapid plant bug, and tarnished plant bug. Two pounds per acre of the technical material (10 pounds of 20 percent dust) is recommended for all these pests, except the cotton fleahopper, rapid plant bug, and tarnished plant bug, which may be controlled with 1.0 pound of technical chlorinated camphene per acre (10 pounds of 10 percent dust).

Results indicated that satisfactory suppression of the cotton aphid was obtained where chlorinated camphene was used throughout the season at the rate of 2 pounds of technical material per acre, but it did not control heavy infestations. It will not control the red spiders and may result in their increase unless the dust contains at least 40 percent sulfur.

Chlorinated camphene kills many of the beneficial insect predators and parasites, but appears to be less objectionable in this respect than most of the other new organic insecticides. It appears to have more residual effect on cotton than the other organic insecticides with the exception of DDT.

Non-alkaline diluents, such as pyrophyllite, sulfur, talcs, and others, are satisfactory with chlorinated camphene. Further studies are needed on the compatibility of this insecticide with diluents and also with other toxicants.



No economic injury to cotton has been reported. Further tests are necessary to determine toxicity to plants and animals.

Little is known regarding the keeping qualities of chlorinated camphene in storage other than the fact that it has been kept satisfactorily from one dusting season until the next.

Chlorinated camphene should be kept away from food and feed and should be handled as a poison.

It appears that this insecticide will be available in 1948 in reasonably adequate quantities.

3422 (O,O-Diethyl-O-p-Nitrophenyl Thiophosphate)

Experimental results with this material were reported from several States. The results showed that it was very effective against aphids and red spiders at concentrations as low as 0.25 percent in some tests, and in all tests it was effective against these insects at concentrations as low as 1 percent. In cage tests it was effective against the boll weevil at 4 percent, and against the bollworm at 5 percent. In field tests it was ineffective against the boll weevil and the bollworm at concentrations of 2 percent. In cage tests it was effective against stink bugs at 5 percent and the rapid plant bug at 2 percent. In cage tests at 1 percent it was as effective as calcium arsenate against the cotton leafworm.

In mixtures with calcium arsenate its effectiveness appears to diminish rather rapidly, but when mixed with organics and non-alkaline diluents, it appears to be stable.

This material is highly poisonous. It has a very disagreeable pungent odor, and in some cases caused headaches, nausea, weakness, and other discomforts to persons exposed to it for relatively short periods. Greatest precautions should be exercised in the use or handling of this material.

Further research is needed with this insecticide both alone and mixed with other insecticides that have shown promise for the control of cotton insects, especially with those organic insecticides which show promise against the boll weevil and the bollworm. Since this insecticide was the only new synthetic organic reported which controlled the red spider in field tests, it deserves an important place in future research on this cotton pest.

Experimental work with this insecticide is too preliminary to permit recommendation for grower use.



### E-3314 - A Chlorinated Hydrocarbon

E-3314 is a product closely related to chlordane. It has been tested against cotton insects in preliminary laboratory and cage tests only. In such tests it was effective against adult boll weevils at a concentration of 2.5 percent; it had the unique property of killing a large percentage of boll weevil larvae inside cotton squares; at 2.5 percent it was effective against the cotton fleahopper; at 10 percent it was effective against the cotton aphid, cotton leafworm, and stink bugs. Twenty percent concentrations controlled the bollworm. It was not effective against the red spider.

No injury to cotton foliage was noted following its use, and dust compositions with pyrophyllite had good dusting qualities and no objectionable odor. Little is known of the toxicity of this material to higher animals, and therefore precautions should be observed in its use.

E3314 has been available in limited experimental quantities, and research with it will depend upon the extent to which it becomes available. This material is likely to be more expensive than chlordane, chlorinated camphene, or benzene hexachloride.

### DDT

DDT appears to be particularly useful for the control of the following insects: bollworm, pink bollworm, cotton fleahopper, tarnished plant bug, rapid plant bug, and thrips. It does not control adequately, the boll weevil, cotton leafworm, or cotton aphid.

In general, DDT is used as a dust for cotton insect control at concentrations of not less than 5% or more than 10% either alone or in admixture with other insecticides. A mixture successfully used on cotton contained 5% DDT, 3% gamma benzene hexachloride, and approximately 40% sulfur.

In general, 5% DDT dusts at 10 to 15 pounds per acre have been found sufficient for control of all susceptible insects in the Southeastern States. For Western conditions, 5 or 10% dusts are desirable. Bollworm and pink bollworm infestations require the higher rates of application; the lower concentrations and dosages are effective for most of the other insects.

When mixed with benzene hexachloride, the dosages recommended for 5% DDT plus 3% gamma benzene hexachloride are from 10 to 15 pounds per acre, depending upon the degree of infestation, size of cotton, and other factors. Applications on larger cotton should be not less than 10 pounds of the mixture for bollworm and pink bollworm control.

Cotton fleahoppers, plant bugs, and thrips can be adequately controlled by 10 to 15 pounds per acre of 5% DDT dust.



DDT, like calcium arsenate, often increases aphid populations to a point where severe damage may occur unless some aphicide is included. Following the use of DDT as a dust either alone or in combination, bollworm infestations sometimes occur after treatments are discontinued.

In dosages recommended, DDT appears safe, but it should not be used in excessive quantities until more is known regarding possible harmful residues.

DDT appears to remain toxic to plants in light sandy soils longer than in heavier clay soils and to lose its toxic effects more rapidly in soils containing abundant humus.

In dusting, contamination of adjacent crops from drift should be kept in mind when such crops are to be used as food by man or animals.

The following diluents may be used in formulating DDT mixtures: sulfur, pyrophyllite, neutral talcs, neutral clays, or other neutral or slightly acid materials. Alkaline diluents should not be used in making DDT formulations. DDT appears to be compatible with chlordane and chlorinated camphene and unlikely to injure cotton when used in formulations with these materials. It may also be compatible with 3422. It is not considered compatible with calcium arsenate unless the material is used soon after mixing.

Keeping qualities of mixtures and formulations containing recommended diluents appear to be excellent. Mixtures containing calcium arsenate or other alkaline diluents may not be stable.

Parasites and predators of economic insect pests are in general susceptible to DDT, and biological control is seriously impaired following the use of DDT combinations or of DDT itself.

While toxicity to man and animals appears to be rather low as compared with most inorganic insecticides now in use, caution should be exercised in handling it. Little is known of the cumulative effects of repeated small dosages to man or domestic animals, and for that reason it should be handled with the same precaution as inorganic insecticides.

DDT is highly toxic to fish and amphibians, and precautions should be taken to preclude the possibility of stream pollution.

It appears that DDT will be available in sufficient supply to meet all except possible local shortages which result from poor distribution or unexpected demand.

The following phases of research should be emphasized: new uses; the cause of increase of aphid populations where DDT without aphicides is used; new mixtures with organic and inorganic insecticides; synergistic effects of DDT and other materials in DDT formulations; compatibility with diluents and other insecticides; toxicity, especially by comparisons of cage and field tests, and of the effects of temperature, humidity, or other factors not immediately controllable; residual effect as indicated by toxicity to insects; and from contamination of crops used as food by man or animals.



### Hexaethyl Tetraphosphate

In limited tests, hexaethyl tetraphosphate used fresh from original containers has been shown to be very effective against several important cotton insects, namely, aphids, red spiders, and cotton fleahoppers; but it is relatively ineffective against the boll weevil and bollworm. However, it deteriorates very rapidly when exposed to moist air, is incompatible with alkaline materials, and is very toxic to warm-blooded animals. Other new materials have also shown promise in the control of the above-named susceptible insects, and for these reasons it is not likely that hexaethyl tetraphosphate will be given special attention in research on cotton insects in 1948. The data available do not justify including it in control recommendations for cotton insects.

### Nicotine

Two percent of nicotine in alternate applications of calcium arsenate or 1% nicotine in all applications of this material will prevent a cotton aphid build-up if properly applied.

The source of nicotine may be nicotine sulphate or a fixed nicotine in dust form. The fixed nicotine at 1-1/2% has been found equal to 2% nicotine sulphate.

Three percent nicotine mixed with an alkaline diluent can be used to "knock-out" heavy infestations of cotton aphids if properly applied.

Since the supply of nicotine is limited, other aphicides are urgently needed.

Application of nicotine-mixed dusts should be made only when the air is calm. If applied by airplane, the plane should be flown at a low altitude, just above the cotton plants, and swaths should not be wider than the wing spread of the plane, usually 30 to 40 feet.

Nicotine is highly toxic and therefore should be used with proper precautions.

### Rotenone

In one experiment in South Carolina, calcium arsenate-nicotine, 3% gamma benzene hexachloride plus 5% DDT, and chlorinated camphene at 10 and 20% strengths were compared for boll weevil and cotton aphid control. A mixture of calcium arsenate and 1 percent rotenone gave greater increases in yield than any other treatment and prevented an aphid build-up.

In 1945 mixtures containing rotenone gave greater increases in yield than any other treatment. Sweeping records made where calcium arsenate-rotenone mixtures were used showed that insect populations were less than that following any of the other treatments. This indicates that other injurious insects may be controlled by mixtures containing calcium arsenate and rotenone. These records indicate that additional research is needed to determine the place rotenone may have in cotton insect control. Rotenone is coming into adequate supply, but the cost is still relatively high.



### Ryania

Undiluted Ryania dust was more effective in controlling stink bugs than 10 percent DDT. Ryania did not give satisfactory control of the boll weevil, cotton aphid, pink bollworm, and bollworm.

Concentrated Ryania dusts can be mixed with pyrophyllite or certain clays. Mixtures of Ryania with pyrophyllite and certain clays have good dusting qualities. No information is available on its compatibility with other insecticides.

No injury to cotton, other crops, or to soils has been reported with Ryania. Although it is toxic to higher animals, it is reported that toxic residues do not persist.

Ryania dusts do not appear to have much promise in the field of cotton insect control.

### Sulfur

Sulfur is a useful insecticide and diluent in cotton insect control. It should be included in dust mixtures recommended for red spider and cotton fleahopper control. It is desirable as a diluent for other insecticides where a non-alkaline carrier is needed. It may be used in dust mixtures as a repressive agent for aphids. It is generally available, and the cost is low.

#### "A Proprietary Boll Weevil Spray"

"In experiments in several States, a proprietary boll weevil spray which was sold widely in 1947 failed to control any of the cotton insects or significantly increase cotton yields. The formula of this material is stated to be as follows:

Copper, present as basic Sulphate, as metallic	1.50%
Zinc, present as basic Sulphate, as metallic	1.25%
Lead Arsenate, as $\text{PbHAsO}_4$	0.50%
Calcium Arsenate, as $\text{Ca}_3(\text{AsO}_4)_2$	0.40%
Pyrethrins	0.13%
Mineral Oil	21.00%
Inert Ingredients	75.22%
Total	<u>100.00%</u>

Total Arsenic, as metallic, not less than 0.26%; water soluble arsenic, as metallic, not more than 0.10%; Lead, as metallic, not less than 0.33%.

The use of calcium arsenate and certain organic insecticides gave yields significantly greater than this proprietary boll weevil spray.

This product has no place in cotton insect control."



### Boll Weevil

Calcium arsenate, benzene hexachloride, chlorinated camphene, and chlordane, when used in proper concentrations and properly applied, have proved effective for controlling the boll weevil. In general, the organic insecticides should be applied at the rate of 10 pounds per acre. When used with inert diluents or sulfur, concentrations of benzene hexachloride should contain at least 3% gamma; chlorinated camphene, 20%; and chlordane, 10%. When these insecticides are used for control of boll weevils under farm conditions, other insect problems have to be considered. Complications involving aphids, bollworms, and red spiders may develop when some of these insecticides are used alone for boll weevil control.

Combinations such as 1% to 2% nicotine with calcium arsenate; 3% gamma benzene hexachloride plus 5% DDT, with at least 40% sulfur; and 20% chlorinated camphene with at least 40% sulfur are recommended to farmers for general use.

Control measures should be applied only when definite need is indicated. All insecticides should be applied at intervals of 4 to 5 days until the infestation is brought under control, which usually requires three or more applications. Thereafter, weekly inspections should be made, and subsequent applications made when necessary.

### Bollworm

Reports indicate that the bollworm is becoming more widespread and important as a pest of cotton throughout most States of the Cotton Belt. Causes of outbreaks are complex, some of which are as follows:

1. Changes in cropping systems.- Reduced acreage of cotton and increased acreage of the crops which are hosts of the bollworm, such as alfalfa, small grains, and soybeans, are being grown. There may be times when these serve as hosts to increase bollworm populations in cotton, while at other times they may act as trap crops, depending on time of planting, dates of maturity of the crop, and other seasonal variations.
2. Insecticides.- Application of certain insecticides prior to moth flight causes an increase in aphid populations and their honeydew attracts the moths. The aphids serve as food for predators which would otherwise feed on the bollworm eggs. Low populations of natural enemies of bollworms resulting from use of some insecticides also allow outbreaks to develop.



Choice of insecticides for bollworm control will be governed by several considerations, including availability, cost, and abundance of associated pests.

Most effective materials are: 20% chlorinated camphene, 5% DDT plus 3% gamma benzene hexachloride, and 10% DDT.

Less effective materials are: 5% DDT, calcium arsenate, lead arsenate, and cryolite.

Where red spider control is necessary, at least 40% of the insecticide should be sulfur.

When DDT is used without an aphicide, a higher percentage of sulfur (at least 70%) will aid in suppressing aphids.

All dusts should be applied at the rate of 10 to 15 pounds per acre at each application, the amount depending upon the intensity of the infestation and size of cotton. Applications should be made at 5-day intervals until the infestation is brought under control. The number of applications required may vary from one to five. Applications should begin when 4 to 5 small bollworms are found per 100 terminals.

Special note.- Successful control of the bollworm is dependent upon TIMELINESS of APPLICATION and thorough coverage of the cotton plant throughout the period of injurious infestation.

#### Cotton Aphid

Heavy aphid infestations often follow the use of such insecticides as calcium arsenate for boll weevil control. Injurious infestations seldom occur on fruiting cotton unless some insecticide has been used for control of another insect. Infestations often occur on seedling cotton.

Wind and convection currents greatly reduce the effectiveness of aphicides.

The following insecticides and combinations have controlled cotton aphids: Two percent of nicotine in alternate applications of calcium arsenate or 1 percent of nicotine in all applications will prevent an aphid build-up if properly applied. Three percent of nicotine dust, using either nicotine sulphate or fixed nicotine in an alkaline diluent, will control heavy infestations of aphids if properly applied.

Benzene hexachloride in all applications applied at the rate of one-third pound of the gamma isomer per acre will prevent aphid increase. If used at the rate of one-half pound of gamma isomer per acre, it will "knock out" heavy infestations of aphids when applied under proper conditions.

The mixture of benzene hexachloride and DDT recommended for boll weevil and bollworm control will give results equal to benzene hexachloride used alone.



Tests indicate that a special calcium arsenate containing 1 percent gamma in every application or special calcium arsenate containing 2 percent in alternate applications will give adequate control if applied under proper conditions.

Concentrations of 3422 as low as 1 percent controlled heavy infestations of aphids, but additional research is needed before it can be recommended.

Chlorinated camphene and chlordane gave variable results and are less effective than benzene hexachloride.

In some experiments rotenone has given good aphid control, but more research is needed.

### Cotton Leafworm

For many years calcium arsenate, Paris green, and lead arsenate have been used for control of the cotton leafworm. Where 3% gamma benzene hexachloride, 20% chlorinated camphene, and a mixture of 5% DDT plus 3% gamma benzene hexachloride have been used for control of other cotton insects, these materials have also controlled the cotton leafworm.

Materials that were highly toxic to the cotton leafworm in cage tests during 1947 were 2% 3422, 10% E-3314, 10% DDD, and 10% methoxy analogue of DDT; and field tests should be conducted with these materials.

### Cotton Fleahopper, Tarnished Plant Bug, and Rapid Plant Bug

All of the new synthetic organic insecticides adequately tested have given effective control of the cotton fleahopper, tarnished plant bug, and rapid plant bug. Considering the many factors involved, such as cost, availability, and effectiveness for other cotton insects, their preference appears to be in the following order: chlorinated camphene 10% plus sulfur 40% or more; DDT 5% plus sulfur 75% or more; benzene hexachloride 3% gamma plus sulfur 40% or more; sulfur; and a mixture of sulfur and calcium arsenate 2:1.

Both chlordane and 3422 have given good results against these insects, but more extensive experiments are necessary before recommendations can be made for their use.



### Pink Bollworm

The most effective insecticides now known for control of the pink bollworm are: DDT 5% plus benzene hexachloride 3% gamma; DDT 10% plus benzene hexachloride 2% gamma; and DDT 10%.

Sulfur is the preferred diluent for these formulations. They should be used at the rate of 15 pounds per acre application at weekly intervals.

To date cultural practices have been found to be the most effective method of control of this pest.

The new synthetic organic insecticides need further testing. Hibernation, host plant, and migration studies should be undertaken in Arizona, New Mexico, Oklahoma, Northern Texas, and Florida. Investigations to determine the most effective cultural practices for suppression, eradication, and prevention of further spread in the areas in which it occurs should be undertaken.

### Red Spiders

Sulfur at the rate of 15 to 20 pounds or more per acre is recommended for the control of red spiders.

Dust mixtures of organic insecticides used against other cotton insects should contain at least 40% sulfur to prevent red spider increases.

Laboratory and field tests indicated that a 1 percent 3422 dust was effective against red spiders.

Red spiders often increase following the use of certain insecticides for control of the boll weevil and other cotton insects, probably as a result of the destruction of natural enemies of the mites.

### Bug-Catching Machines

Numerous observations were made following the use of . . . , bug-catching machines on cotton in several States. These machines collected large numbers of insects, but the many beneficial insects taken offsets the good that should have resulted from the collection of the injurious species.

A reduction in parasites and predators has at times resulted in aphid increase.

Records made in many fields where the machines were operated showed that they caused no appreciable reduction in boll weevil infestations. Breakage of the cotton plants became serious when plants were large enough to be in peak of production, at which time boll weevil control is most profitable. In many cases, the use of these machines was discontinued when boll weevil infestations became injurious, and dusting was begun.

Machines for catching boll weevils and other cotton insects are not recommended. No mechanical device has yet been found by federal or State investigators to be equal to chemical methods for controlling cotton insects.



### Equipment for Application of Insecticides

Better equipment for the application of insecticides is needed. For its development, close cooperation with agricultural engineers and cost specialists should be maintained. The new ground dusting machines that have been developed and not tested on cotton should be evaluated for that purpose. When these machines are under test, the advice and criticisms of engineers should be solicited with the view of developing more durable equipment. A critical study should be made of each type of machine with the idea of its adaptability to other farm uses.

In view of the need for larger plots on account of the fumigating action of some of the organic insecticides, a small power dusting machine with removable hoppers should be developed for field plot work.

Air velocity should be studied in all ground machines, and the boomless types should be improved. Positive feeds and feeding apparatus with accurate calibration at all levels of hopper load should be provided for all types of dusters.

Different types of airplanes and airplane dusting and spraying equipment should be studied, improved, and developed for greater efficiency of dispersal and deposit of insecticides.

More suitable apparatus for application of concentrated sprays should be developed. Mist blowers, sprayers, and thermal aerosol machines should be studied.

Research is urgently needed on all types of ground and aerial equipment for applying insecticides on cotton.

### Cotton Entomologists and Associated Technical Workers

Cotton entomologists and associated technical workers from the Agricultural Experiment Stations and Extension Service in 10 leading cotton-growing States and from the United States Department of Agriculture and National Cotton Council of America who participated in the Cotton Insect Control Conference at the Delta Branch Experiment Station, Stoneville, Mississippi, on November 17, 18, and 19, 1947, were:

#### Alabama

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